

Original document

# Improvements in apparatus for contacting a liquid with a liquid or a particulate solid

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Inventor: MORRIS WILLIAM HADYN

Applicant: SECR AVIATION

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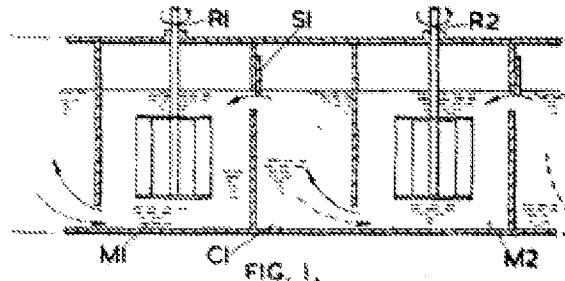
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## Abstract of GB974829

The apparatus of the parent Specification is modified by the use of an adjustable barrier which restricts the movement of the dispersed phase on entering or immediately after entering each displacement vessel C1 &c. from an <PICT:0974829/C1/1> adjacent mixing vessel M1, M2 &c. The barriers may be shutters S1 &c. as shown or shutters and baffles (Figs. 2, 3 and 4, not shown).



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## Description of GB974829

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## PATENT SPECIFICATION

## DRAWINGS ATTACHED.

Inventor: -WILLIAM HADYN MORRIS.

974,829 Date of Application and filing Complete Specification:

Jan 15, 1963 No 1733163.

(Patent of Addition to No 885,503, dated Jan 10, 1958).

Complete Specification Published: Nov 11, 1964.

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Index at Acceptance:-C 1 C 12 X.

International Classification:-C 02 b.

## COMPLETE SPECIFICATION.

Improvements in Apparatus for Contacting a Liquid with a Liquid or a Particulate Solid.

I, MINISTER OF AVIATION, London, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to apparatus for contacting a liquid with a liquid or a particulate solid, as occurs in a wide variety of industrial processes such as, for example,

leaching or extraction, washing or chemical reaction processes.

The invention provides improvements in or modifications of the apparatus described in Patent Specification No 885,503 for contacting two components of different densities in which the desired interaction between the two components takes place by means of a counter-current flow of the two components in a series of vessels arranged horizontally or substantially horizontally.

Apparatus according to the invention described and claimed in Patent Specification No 885,503 for counter-currently contacting two immiscible or at least partly immiscible components of different densities, one component being a liquid and the other being a second liquid or a particulate solid, comprises a single series of interconnecting vessels which may be filled with the components and which are alternately mixing vessels and upright counter-current displacement vessels, each mixing vessel having only two interconnecting openings of which a lower opening connects the base region of each mixing vessel to the base region of the adjacent counter-current displacement vessel in the series in one direction and an upper opening connects each mixing vessel to the adjacent counter-current displacement vessel in the series in the other direction near to the level of the liquid surface when in the vessels, and a mixing device in each mixing vessel for mixing the components throughout the whole height of the mixing vessels 45 whereby in operation the mixed components are swept through the interconnecting openings into and across the adjacent countercurrent displacement vessels and countercurrent displacement of the two components 50 takes place in the counter-current displacement vessels by counter-current movement of droplets or particles of one component distributed freely in the other component so that the two components are displaced 55 through the series of vessels in opposite directions.

There is negligible separation of the components into two separate phases in the displacement vessels, which function on the spray-tower principle with the denser phase falling and the less dense phase rising under the influence of gravity so that interaction between the two components takes place in the displacement vessels as well as in the mixing vessels.

The throughput of each component that can be passed through the plant under these counter-current conditions is dependent upon various dimensions of the plant similarly, the residence time, that is the hold-up time, of each component and the phase ratio of the components in the vessels are dependent upon the plant dimensions.

Each particular process requires certain operating conditions of throughput, residence time and phase ratio for the components and to obtain these the plant must have appropriate dimensions. In particular in some processes the time that the components remain in contact in the mixing vessel is critical and the component with the shortest residence time in the mixing vessel governs the contact time. For such a process the plant must be accurately designed and it has been found that an important factor is the cross-sectional area of the displacement vessel in relation to the volume of the mixing vessel. When the cross-sectional area of the displacement vessel is too large in relation to the volume of the mixing vessel the residence time of the dispersed phase in the mixing vessel is inadequate, whereas too small a cross-sectional area of the displacement vessel results in an insufficient countercurrent throughput. As a result plant must be accurately designed for a given process and cannot be used for processes whose operating conditions vary widely therefrom.

The present invention provides an improved form of apparatus that can be readily assembled. In one embodiment the barrier will be placed at or opposite the lower opening of the displacement vessel.

A versatile plant is provided with adjustable barriers at both the upper and lower openings of each displacement vessel. Variation of the size of the opening connecting a displacement vessel with its adjacent mixing vessel does not restrict the flow of the dispersed phase until the size of the opening is reduced to below a certain minimum size. When the control is by means of a shutter it can be improved by limiting the width of the opening through which the vessels communicate so that it is less than half the width of the wall dividing the displacement vessel from its adjacent mixing vessel. The width of the opening can be reduced to about one sixth of the width of the dividing wall without significantly reducing the counter-current throughput provided that the opening is of sufficient Month. nrrno cmint nn-a ts - nth nf th O ir'lth k.

V \_\_ ; I nd \_\_ I' I Uk I 974,829 974,829 3 sage of the dispersed phase from the mixing vessels M1 and M2 into the displacement vessel C1. When the dispersed phase is denser than the continuous phase (Figure 1) the dispersed phase passes from the mixing vessel M1 into the displacement vessel C1 and lowering the shutter 51 into the liquid reduces the depth of the opening and when this is below a certain minimum size restricts the freedom of movement of the dispersed phase from the mixing vessel M1 thus increasing its residence time therein. When the dispersed phase is less dense than the continuous phase (Figure 2) the dispersed phase passes from the mixing vessel M2 into the displacement vessel C1 and lowering the shutter 52 reduces the depth of the opening and when this is below a certain minimum size restricts the freedom of movement of the dispersed phase from the mixing vessel M2 and increases its residence time therein. The residence time of the dispersed phase in the mixing vessel M1 or M2 is increased by increasing the distance that the respective shutter 51 or 52 is lowered thereby decreasing the depth of the opening.

Figures 3 and 4 show the arrangement when the baffles are used to restrict the passage of the dispersed phase from the mixing vessels M1 or M2 into the displacement vessel C1. When the dispersed phase is denser than the continuous phase, the baffle B1 is positioned as shown in Figure 3 opposite the upper opening of the displacement vessel C1 and restricts the freedom of movement of the dispersed phase from the mixing vessel M1, thus increasing its residence time therein. When the dispersed phase is less dense than the continuous phase baffle B2 is positioned as shown in Figure 4 opposite the lower opening of the displacement vessel C1 and restricts the freedom of movement of the dispersed phase from the mixing vessel M1, thus increasing its residence time therein. Each baffle B1 and B2 is arranged to be movable in position horizontally across the displacement vessel from one side wall to a position close to the opening, the closer that the baffle is positioned to the opening that it is controlling, the greater is the residence time of the dispersed phase in the mixing vessel.

Although the modifications hereinbefore described and shown in the accompanying drawings are particularly applicable to the apparatus illustrated in Figure 1 of the drawings attached to Patent Specification

No 885,503, it will be seen that the apparatus illustrated in Figures 2 and 3 can be similarly modified.

Generally the apparatus is arranged so that the dispersed phase has the same residence time in all the mixing vessels of the apparatus when it is being used for straightforward continuous counter-current application 65 ions. Occasionally, however, the process or processes for which the apparatus is being employed may require different residence times in the various mixers, for example when the apparatus is being used for a 70 counter-current reaction process in which the rate of the reaction varies at different stages of the plant. The residence time can then be adjusted to the optimum for that stage. This is of particular advantage in 75 those reactions where as residence time in excess of the optimum at any stage may result in unwanted side-reactions.

It may also be necessary for the components to remain in different mixing vessels 80 for different times if the apparatus is employed to carry out two or more processes, consecutively or concurrently by either counter-current or co-current methods. The present invention simplifies the means by 85 which this can be done.

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#### Claims of GB974829

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#### WHAT I CLAIM IS: -

1 Apparatus according to any claim of Patent Specification No 885,503 which is provided with an adjustable barrier arranged 90 to restrict the freedom of movement of the dispersed phase on entering or immediately after entering each displacement vessel from an adjacent mixing vessel.

2 Apparatus according to Claim 1, in 95 which the barrier is a shutter arranged to alter the size of the opening between each displacement vessel and adjacent mixing vessel through which the dispersed phase enters the displacement vessel 100. 3 Apparatus according to Claim 2, in which the width of the opening through which the dispersed phase enters the displacement vessel is between about one half and one sixth of the width of the plant, and 105 the depth of the opening can be altered.

4 Apparatus according to Claim 1, in which the carrier is a baffle adjustably positioned opposite the opening through which the dispersed phase enters the displacement vessel 110.

Apparatus according to Claim 4, in which the said baffle extends the full width of the displacement vessel and from the level of the opening that it controls to a level 115 about midway between the levels of the two openings of the displacement vessel.

6 Apparatus according to any claim of Patent Specification No 885,503 which has been modified substantially as hereinbefore described with reference to any one of the accompanying drawings.

J V GOODFELLOW, Chartered Patent Agent, Agent for the Applicant.

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# PATENT SPECIFICATION

974,829

DRAWINGS ATTACHED.

Inventor: —WILLIAM HADYN MORRIS.

974,829



Date of Application and filing Complete Specification :  
Jan. 15, 1963. No. 1733/63.

(Patent of Addition to No. 885,503, dated Jan. 10, 1958).

Complete Specification Published : Nov. 11, 1964.

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Index at Acceptance :—C1 C12X.

International Classification :—C 02 b.

## COMPLETE SPECIFICATION.

### Improvements in Apparatus for Contacting a Liquid with a Liquid or a Particulate Solid.

I, MINISTER OF AVIATION, London, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to apparatus for contacting a liquid with a liquid or a particulate solid, as occurs in a wide variety of industrial processes such as, for example, leaching or extraction, washing or chemical reaction processes.

The invention provides improvements in or modifications of the apparatus described in Patent Specification No. 885,503 for contacting two components of different densities in which the desired interaction between the two components takes place by means of a counter-current flow of the two components in a series of vessels arranged horizontally or substantially horizontally.

Apparatus according to the invention described and claimed in Patent Specification No. 885,503 for counter-currently contacting two immiscible or at least partly immiscible components of different densities, one component being a liquid and the other being a second liquid or a particulate solid, comprises a single series of interconnecting vessels which may be filled with the components and which are alternately mixing vessels and upright counter-current displacement vessels, each mixing vessel having only two interconnecting openings of which a lower opening connects the base region of each mixing vessel to the base region of the adjacent counter-current displacement vessel in the series in one direction and an upper opening connects each mixing vessel to the adjacent counter-current displacement vessel

in the series in the other direction near to the level of the liquid surface when in the vessels, and a mixing device in each mixing vessel for mixing the components throughout the whole height of the mixing vessels whereby in operation the mixed components are swept through the interconnecting openings into and across the adjacent counter-current displacement vessels and counter-current displacement of the two components takes place in the counter-current displacement vessels by counter-current movement of droplets or particles of one component distributed freely in the other component so that the two components are displaced through the series of vessels in opposite directions.

There is negligible separation of the components into two separate phases in the displacement vessels, which function on the spray-tower principle with the denser phase falling and the less dense phase rising under the influence of gravity so that interaction between the two components takes place in the displacement vessels as well as in the mixing vessels.

The throughput of each component that can be passed through the plant under these counter-current conditions is dependent upon various dimensions of the plant. Similarly, the residence time, that is the hold-up time, of each component and the phase ratio of the components in the vessels are dependent upon the plant dimensions.

Each particular process requires certain operating conditions of throughput, residence time and phase ratio for the components and to obtain these the plant must have appropriate dimensions. In particular in some processes the time that the com-

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ponents remain in contact in the mixing vessel is critical and the component with the shortest residence time in the mixing vessel governs the contact time. For such a process the plant must be accurately designed and it has been found that an important factor is the cross-sectional area of the displacement vessel in relation to the volume of the mixing vessel. When the cross-sectional area of the displacement vessel is too large in relation to the volume of the mixing vessel the residence time of the dispersed phase in the mixing vessel is inadequate, whereas too small a cross-sectional area of the displacement vessel results in an insufficient counter-current throughput. As a result plant must be accurately designed for a given process and cannot be used for processes whose operating conditions vary widely therefrom.

The present invention provides an improved form of apparatus that can be readily modified to enable processes requiring widely

the barrier will be placed at or opposite the lower opening of the displacement vessel.

A versatile plant is provided with adjustable barriers at both the upper and lower openings of each displacement vessel.

Variation of the size of the opening connecting a displacement vessel with its adjacent mixing vessel does not restrict the flow of the dispersed phase until the size of the opening is reduced to below a certain minimum size. When the control is by means of a shutter it can be improved by limiting the width of the opening through which the vessels communicate so that it is less than half the width of the wall dividing the displacement vessel from its adjacent mixing vessel. The width of the opening can be reduced to about one sixth of the width of the dividing wall without significantly reducing the counter-current throughout provided that the opening is of sufficient depth, normally about one tenth of the width

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- sage of the dispersed phase from the mixing vessels M1 and M2 into the displacement vessel C1. When the dispersed phase is denser than the continuous phase (Figure 1) 5 the dispersed phase passes from the mixing vessel M1 into the displacement vessel C1 and lowering the shutter S1 into the liquid reduces the depth of the opening and when this is below a certain minimum size restricts 10 the freedom of movement of the dispersed phase from the mixing vessel M1 thus increasing its residence time therein. When the dispersed phase is less dense than the continuous phase (Figure 2) the dispersed 15 phase passes from the mixing vessel M2 into the displacement vessel C1 and lowering the shutter S2 reduces the depth of the opening and when this is below a certain minimum size restricts the freedom of movement 20 of the dispersed phase from the mixing vessel M2 and increases its residence time therein. The residence time of the dispersed phase in the mixing vessel M1 or M2 is increased by increasing the distance that the 25 respective shutter S1 or S2 is lowered thereby decreasing the depth of the opening.

Figures 3 and 4 show the arrangement when the baffles are used to restrict the passage of the dispersed phase from the mixing 30 vessels M1 or M2 into the displacement vessel C1. When the dispersed phase is denser than the continuous phase, the baffle B1 is positioned as shown in Figure 3 opposite the upper opening of the displacement vessel C1 and restricts the freedom of movement of the dispersed phase from the mixing vessel M1, thus increasing its residence 35 time therein. When the dispersed phase is less dense than the continuous phase 40 baffle B2 is positioned as shown in Figure 4 opposite the lower opening of the displacement vessel C1 and restricts the freedom of movement of the dispersed phase from the mixing vessel M1, thus increasing its residence time therein. Each baffle B1 45 and B2 is arranged to be movable in position horizontally across the displacement vessel from one side wall to a position close to the opening, the closer that the baffle is positioned to the opening that it is controlling, the greater is the residence time of the dispersed phase in the mixing vessel. 50

Although the modifications hereinbefore described and shown in the accompanying 55 drawings are particularly applicable to the apparatus illustrated in Figure 1 of the drawings attached to Patent Specification No. 885,503, it will be seen that the apparatus illustrated in Figures 2 and 3 can be 60 similarly modified.

Generally the apparatus is arranged so that the dispersed phase has the same residence time in all the mixing vessels of the apparatus when it is being used for straight-

forward continuous counter-current applications. Occasionally, however, the process or processes for which the apparatus is being employed may require different residence times in the various mixers, for example when the apparatus is being used for a counter-current reaction process in which the rate of the reaction varies at different stages of the plant. The residence time can then be adjusted to the optimum for that stage. This is of particular advantage in those reactions where as residence time in excess of the optimum at any stage may result in unwanted side-reactions. 65

It may also be necessary for the components to remain in different mixing vessels for different times if the apparatus is employed to carry out two or more processes, consecutively or concurrently by either counter-current or co-current methods. The present invention simplifies the means by 70 which this can be done. 75

#### WHAT I CLAIM IS:—

1. Apparatus according to any claim of Patent Specification No. 885,503 which is provided with an adjustable barrier arranged to restrict the freedom of movement of the dispersed phase on entering or immediately after entering each displacement vessel from an adjacent mixing vessel. 90

2. Apparatus according to Claim 1, in which the barrier is a shutter arranged to alter the size of the opening between each displacement vessel and adjacent mixing vessel through which the dispersed phase enters the displacement vessel. 95

3. Apparatus according to Claim 2, in which the width of the opening through which the dispersed phase enters the displacement vessel is between about one half and one sixth of the width of the plant, and the depth of the opening can be altered. 100

4. Apparatus according to Claim 1, in which the carrier is a baffle adjustably positioned opposite the opening through which the dispersed phase enters the displacement vessel. 110

5. Apparatus according to Claim 4, in which the said baffle extends the full width of the displacement vessel and from the level of the opening that it controls to a level about midway between the levels of the two openings of the displacement vessel. 115

6. Apparatus according to any claim of Patent Specification No. 885,503 which has been modified substantially as hereinbefore described with reference to any one of the accompanying drawings. 120

J. V. GOODFELLOW,  
Chartered Patent Agent,  
Agent for the Applicant.

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## COMPLETE SPECIFICATION

1 SHEET

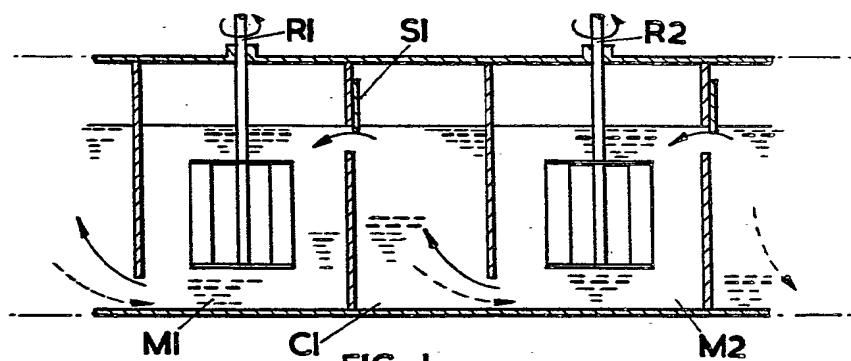
*This drawing is a reproduction of  
the Original on a reduced scale*

FIG. 1.

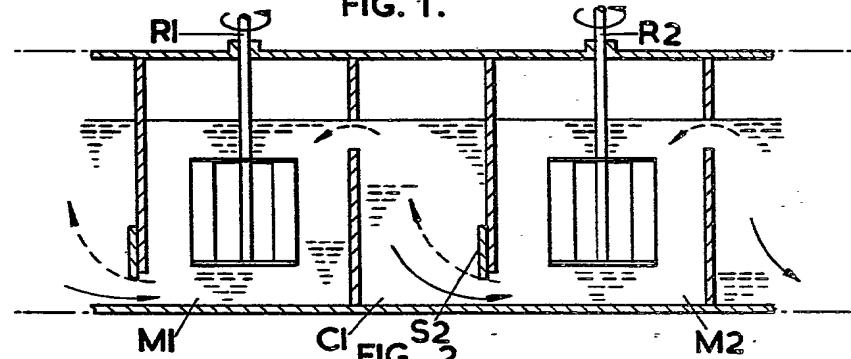


FIG. 2.

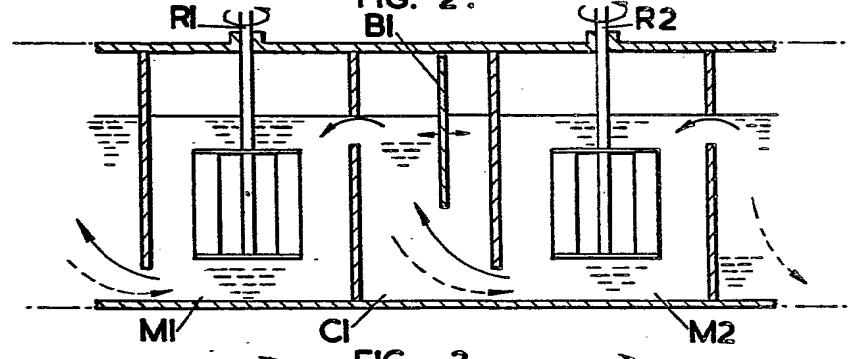


FIG. 3.

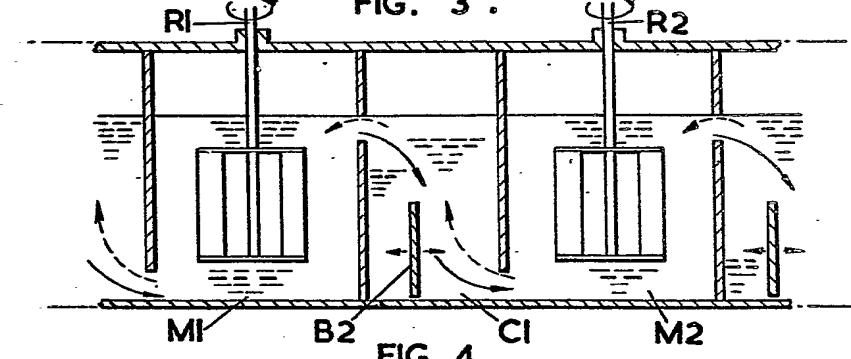


FIG. 4.